

APPENDIX A

SECTION A-2-CLEAR ZONE/LATERAL OFFSET GUIDELINES

Introduction	A-1
Roadways With Shoulders	A-2
Roadways With Curb.....	A-3
Clear Zone Cost-Effectiveness Analysis	A-4
Embankment Slopes	A-5
Horizontal Curve Adjustments.....	A-6
Showing Clear Zones/ Lateral Offsets on Typical Sections.....	A-7
Non-Recoverable Parallel Slopes	A-8

LIST OF FIGURES

Figure A-2-1 Clear Zone (Lateral Offset) Cases	A-5
Figure A-2-1A Clear Zone (Lateral Offset) Cases	A-6
Figure A-2-2 Cost Effective Selection Procedures	A-8
Table A-2-2 Horizontal Curve Adjustments.....	A-9
Figure A-2-4 Example of A Parallel Embankment Slope Design.....	A-11

SECTION A-2-CLEAR ZONE/LATERAL OFFSET GUIDELINES

INTRODUCTION

The term “clear zone” is used to describe the unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of an errant vehicle. The clear zone includes shoulders, bike lanes, parking lanes and auxiliary lanes (except those auxiliary lanes that function like through lanes). Clear zone distances are based upon traffic volume, speed, and embankment slopes.

A recoverable area is to be provided that is clear of all unyielding obstacles such as trees, sign supports, utility poles, light poles, or any other fixed objects that might severely damage an out-of-control vehicle (See 2011 AASHTO *A Policy on Geometric Design of Highways and Streets*, Chapter 5). Determining a practical clear zone often involves a series of compromises between absolute safety, engineering judgment, environmental and economic constraints. Additional information is available in AASHTO’s *Roadside Design Guide*.

ROADWAYS WITH SHOULDERS

In rural environments, where speeds are higher and constraints are fewer, a clear zone appropriate for the traffic volume, design speed, and facility type should be provided in accordance with the AASHTO *Roadside Design Guide*, Chapter 3. These values also are applicable for freeways and other controlled-access facilities in urban areas. For an example, see Figure A-2-1, Case 1.

Whenever adequate right of way is available, urban projects should be designed with shoulders in lieu of curbs (unless city ordinances require otherwise) and clear zone widths should be consistent with the requirements for roadways with shoulders. (See 2011* AASHTO *“A Policy on Geometric Design of Highways and Streets”*, Chapter 7). The justification for providing a curb is to be documented in the project file (e.g. Preliminary Field Inspection Report, recommendation from Right of Way and Utilities Division, etc.).

Roadways* with paved shoulders should provide as much clear zone as practical in accordance with Table A-2-1, which is from the AASHTO *Roadside Design Guide*. (See 2011 AASHTO *A Policy on Geometric Design of Highways and Streets*, Chapters 4, 5 and 6). For an example, see Figure A-2-1, Case 1.

On projects such as RRR, intersection improvements, etc. recoverable areas are not always practical due to the intent of the project to provide minimal improvements and extend the service life of the existing roadway for a fraction of the costs of reconstruction. However, as much clear zone as practical should be provided.

Sources: *TRB Special Report 214, Designing Safer Roads* / 2011 AASHTO *A Policy on Geometric Design of Highways and Streets*, Chapters 4-7 / 2011 AASHTO *Roadside Design Guide*.

* Rev. 7/16

ROADWAYS WITH CURB

For urban arterials and other non-controlled access facilities in an urban environment, right of way is often extremely limited. In many cases, establishing a clear zone using the guidance in the *Roadside Design Guide*, Chapter 3 is not practical. These urban environments are often characterized by sidewalks beginning at the back of the curb, enclosed drainage, numerous fixed objects (e.g. signs, utility poles, luminaire supports, fire hydrants, sidewalk furniture), and frequent traffic stops. These environments typically have lower operating speeds and in many instances, on-street parking. In these environments, a lateral offset to vertical obstructions (e.g. signs, utility poles, luminaire supports, fire hydrants), including breakaway devices, is needed to accommodate motorist operating on the highway.

When providing clear zone in accordance with the *Roadside Design Guide* in an urban area is not practical, consideration should be given to incorporating as many clear-zone concepts as practical, such as removing roadside objects or making them crashworthy. Ideally, appurtenances (e.g. benches, trash barrels, bicycle racks) should be located as far away as practical, but at least 4 feet from the face of curb. Breakaway designs shall be used for poles and appurtenances located less than 6 feet from the face of curb. See Figure A-2-1, Case 2 and Figure A-2-1A, Case 3 and Case 4.

Although the clear roadway concept is still the goal, many compromises are likely in urban or restricted environments. A minimum lateral offset of 1.5 feet shall be provided beyond the face of curb, with 3 feet minimum at intersections and driveway openings (10'–15' recommended, See *Roadside Design Guide*, Chapter 10). Lateral offset does not meet clear zone criteria but simply enables normal facility operations by providing clearance for turning trucks, etc. Consideration should be given to providing more than the minimum lateral offset to obstructions by placing **frangible*** objects behind the sidewalk or sidewalk space. See Figure A-2-1, Case 2 and Figure A-2-1A, Case 3.

A common misconception is that a curb with a 1.5 ft. lateral offset behind it satisfies the clear roadside concept. Curbs have limited re-directional capabilities and these occur only at low speeds, approximately 25 mph or lower. Fixed objects located adjacent to the travel lane, even in the presence of curbs, pose a potential hazard. Achieving the clear zone distances suggested in Chapter 3 may be unlikely in an urban setting. As a result, a secondary goal for roadside design in an urban setting is to identify critical urban roadside locations, such as (bridge terminal walls, retaining walls, soundwalls, and sloped or vertical drop offs in the clear zone), and give these locations priority attention for roadside safety improvements.

Note that curb is applicable to roadways with design speeds \leq 45 mph and should ONLY be used on roadways $>$ 45 mph in special situations. These situations may include, but are not limited to drainage considerations, a need for access control and right of way restrictions. Curbed roadways with design speeds $>$ 45 mph shall provide the required clear-zone or shield non-breakaway objects in accordance with Appendix J.

* Rev. 7/19

A barrier may be required on the back side of a sidewalk or shared use path based on the fill slope and vertical elevation drop-off. Note pedestrian railings are not breakaway devices and shall be located outside of the clear-zone. See [Figure A\(1\)-1-6 and A\(1\)-1-24](#).

When a vertical drop-off or other hazard is located within the clear zone, barrier should be considered, see [Appendix J, Section J-3, Barrier Warrants](#). For instructions on the placement of guardrail adjacent to curb, see [Appendix J, Section J-3, Guardrail Installation Adjacent to Curb](#).

Any fixed objects (signs, luminaire supports, large trees, etc.) located within a curbed median should not be located less than 6' from the face of curb. See Figure A-2-1A, Case 4.

Source: AASHTO Green Book, Chapter 4, Section 4.7.1, page 4-16 and ASSHTO *Roadside Design Guide*, Chapter 3 and Chapter 10.

STREETSCAPE AND LANDSCAPE

[See Appendix B\(1\)](#)*

* Rev. 1/20

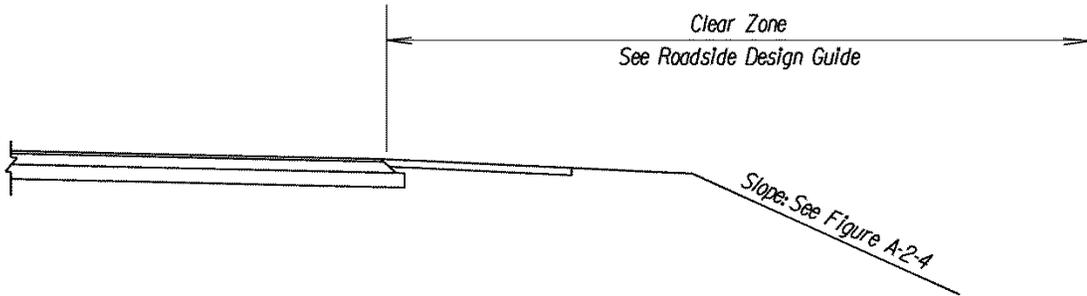
DESIGN SPEED	DESIGN ADT	FORESLOPES			BACKSLOPES		
		6:1 or Flatter	5:1 to 4:1	3:1	3:1	5:1 to 4:1	6:1 or Flatter
40 mph or less	Under 750 ^c	7-10	7-10	b	7-10	7-10	7-10
	750-1500	10-12	12-14	b	10-12	10-12	10-12
	1500-6000	12-14	14-16	b	12-14	12-14	12-14
	Over 6000	14-16	16-18	b	14-16	14-16	14-16
45-50 mph	Under 750 ^c	10-12	12-14	b	8-10	8-10	10-12
	750-1500	14-16	16-20	b	10-12	12-14	14-16
	1500-6000	16-18	20-26	b	12-14	14-16	16-18
	Over 6000	20-22	24-28	b	14-16	18-20	20-22
55 mph	Under 750 ^c	12-14	14-18	b	8-10	10-12	10-12
	750-1500	16-18	20-24	b	10-12	14-16	16-18
	1500-6000	20-22	24-30	b	14-16	16-18	20-22
	Over 6000	22-24	26-32 ^a	b	16-18	20-22	22-24
60 mph	Under 750 ^c	16-18	20-24	b	10-12	12-14	14-16
	750-1500	20-24	26-32 ^a	b	12-14	16-18	20-22
	1500-6000	26-30	32-40 ^a	b	14-18	18-22	24-26
	Over 6000	30-32 ^a	36-44 ^a	b	20-22	24-26	26-28
65-70 ^d mph	Under 750 ^c	18-20	20-26	b	10-12	14-16	14-16
	750-1500	24-26	28-36 ^a	b	12-16	18-20	20-22
	1500-6000	28-32 ^a	34-42 ^a	b	16-20	22-24	26-28
	Over 6000	30-34 ^a	38-46 ^a	b	22-24	26-30	28-30

Source: AASHTO *Roadside Design Guide*, Chapter 3.

TABLE A-2-1

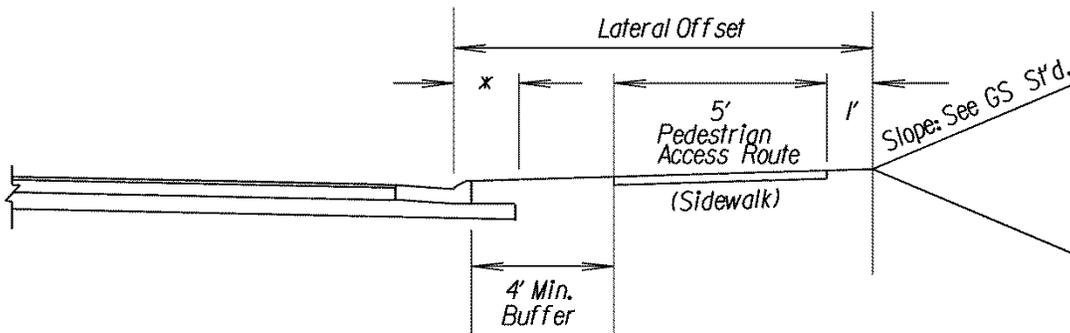
CLEAR ZONE DISTANCES (IN FEET FROM EDGE OF DRIVING LANE)

- a. When a site specific investigation indicates a high probability of continuing crashes, or when such occurrences are indicated by crash history, the designer may provide clear zone distances greater than the clear zone shown in Table A-2-1. Clear zones may be limited to 30 feet for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.
- b. Because recovery is less likely on the unshielded, traversable 3:1 fill slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Recovery of high speed vehicles that encroach beyond the edge of shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right of way availability, environmental concerns, economic factors, safety needs, and crash histories. Also, the distance between the edge of the travel lane and the beginning of the 3:1 slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the fill slope parameters which may enter into determining a maximum desirable recovery area are illustrated in FIGURE A-2-4. A 10 foot recovery area at the toe of slope should be provided for all traversable, non-recoverable fill slopes.
- c. For roadways with low volumes it may not be practical to apply even the minimum values found in Table A-2-1. Refer to Chapter 12 for additional considerations for low volume roadways and Chapter 10 for additional guidance for urban applications in AASHTO *Roadside Design Guide*.
- d. When design speeds are greater than the values provided, the designer may provide clear zone distances greater than those shown in Table A-2-1.



CASE 1- SHOULDER AND DITCH

* 1.5' Minimum Lateral Offset in Constrained Low-Speed Urban Environments.

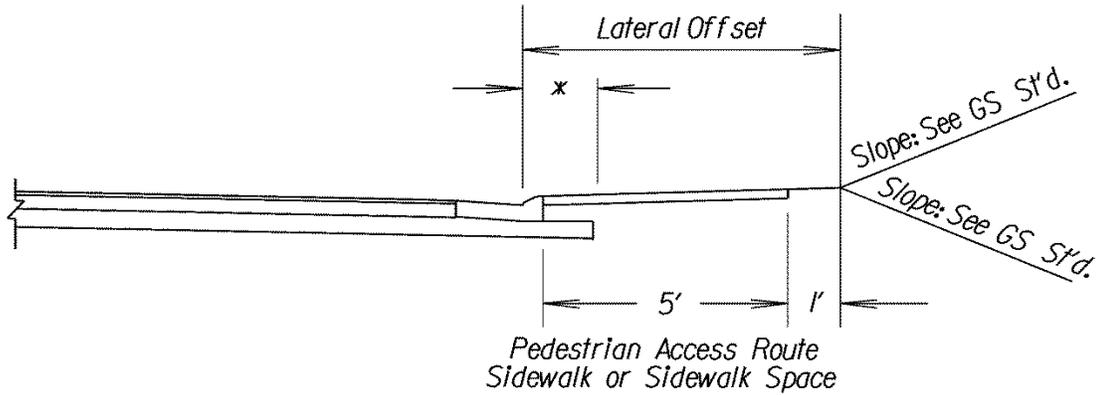


CASE 2 – CURB WITH BUFFER STRIP AND SIDEWALK

FIGURE A-2-1*

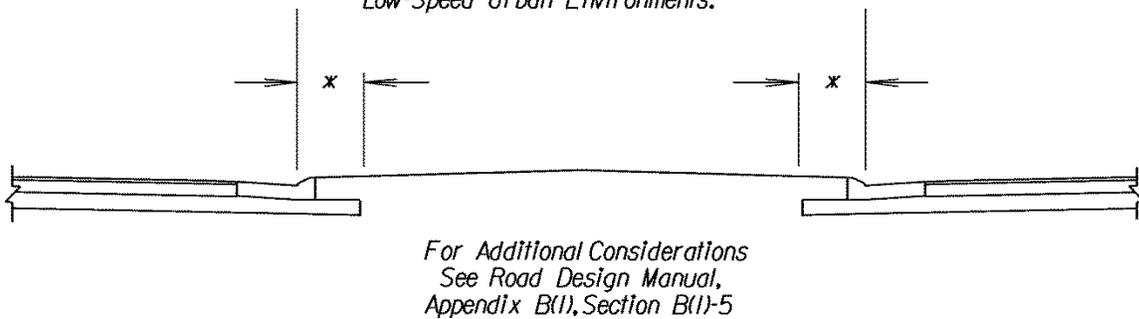
* Rev. 7/16

* 1.5' Minimum Lateral Offset in Constrained Low-Speed Urban Environments.



CASE 3 – CURB SIDEWALK OR SIDEWALK WITH SPACE*

* 1.5' Minimum Lateral Offset in Constrained Low-Speed Urban Environments.



For Additional Considerations
See Road Design Manual,
Appendix B(1), Section B(1)-5

CASE 4 – CURBED MEDIAN

FIGURE A-2-1A

* Rev. 7/16

CLEAR ZONE COST-EFFECTIVENESS ANALYSIS

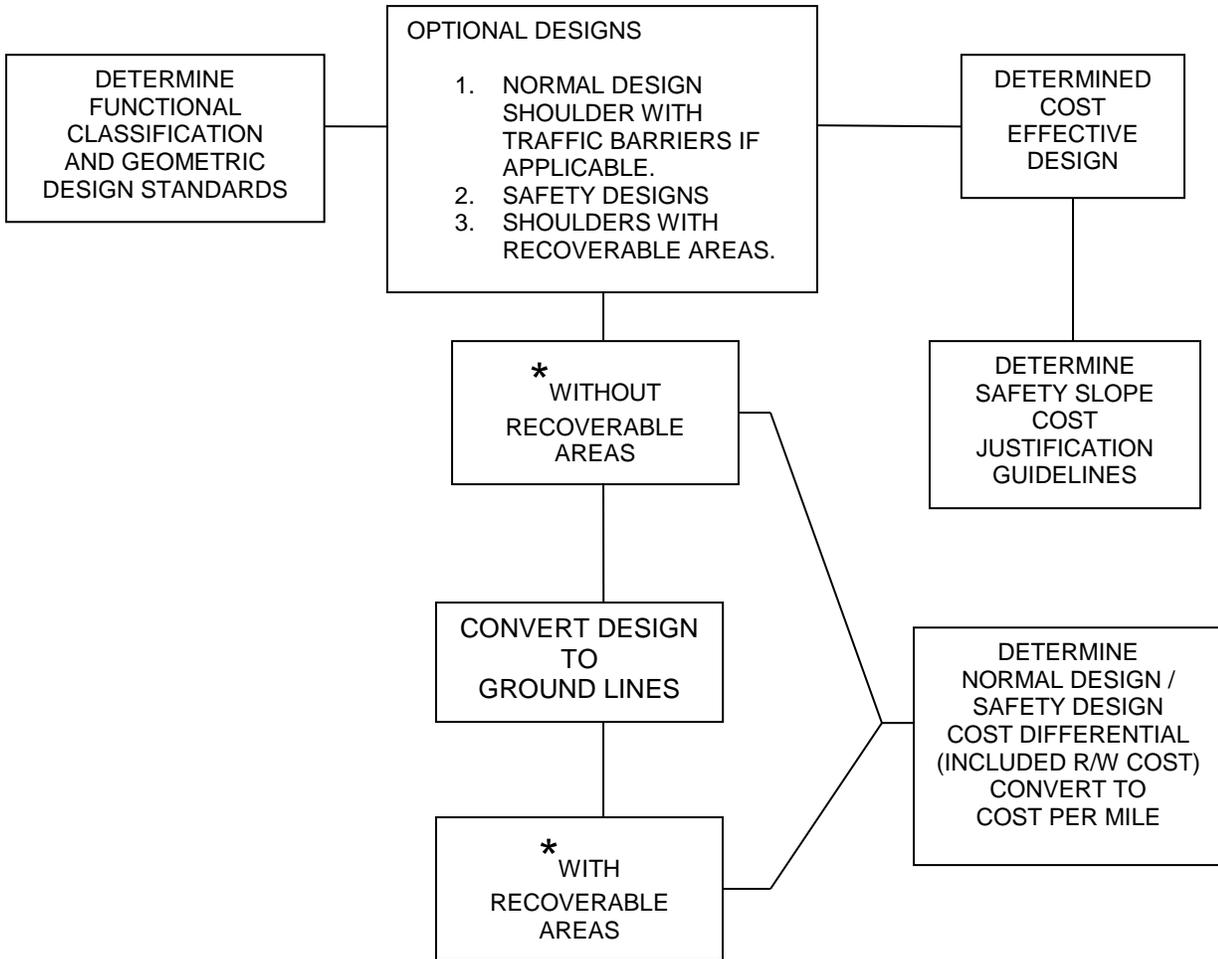
For projects where the clear zone widths from the AASHTO *Roadside Design Guide* are under consideration, Freeways; Rural and Urban Arterials (with shoulders); and Rural and Urban Collectors (with shoulders) with design speeds of 50 mph or greater and with a design year ADT greater than 2000, an early cost-effectiveness analysis is required to determine the feasibility of providing the recoverable areas to meet the clear zone requirements shown in TABLE A-2-1.

This analysis should be done during the preliminary plan development process and should involve determining the additional construction and R/W costs to provide the desired clear zone. Refer to AASHTO's *Roadside Design Guide*, Chapter 2, for "Economic Evaluation of Roadside Safety".* Any other procedure which will provide this cost is acceptable as long as it is documented in the project files. After the additional cost to provide the recoverable area is determined, it should be compared to the estimated accident cost without the recoverable area. This cost comparison along with good engineering judgment should be used to determine the feasibility of providing the recoverable areas through the project and should be documented on the Field Review and Scoping Report [PM-100](#).

Prior to establishing the additional construction and R/W cost estimate, the developed areas that would involve heavy R/W damages and/or relocations or environmental restrictions such as park properties, historic areas or wetlands should be noted and where practicable horizontal and vertical alignment adjustments are to be made to provide the desired recoverable areas and clear zones. In these situations alternate designs may include elimination of ditches and/or median width reductions with possible incorporation of raised medians or median barrier to reduce required R/W.

A suggested procedure is shown in FIGURE A-2-2 to develop the difference in cost between the typical section based on the project's functional classification and proper Geometric Design Standards and the typical section with the desired recoverable areas.

* Rev. 1/12



* GEOPAK DESIGN CROSS SECTION LISTING
EARTHWORK VOLUME COMPUTATIONS

FIGURE A-2-2
COST EFFECTIVE SELECTION PROCEDURES

Note: Upon receipt of normal design and safety design earthwork quantities, a cursory review may indicate that the cost per side for the earthwork alone far exceeds the cost per mile for safety slopes, thereby eliminating the need to determine the other additional costs such as drainage extensions, right of way, etc*.

EMBANKMENT SLOPES

Embankment slopes must have a relatively smooth and firm surface to be truly recoverable or traversable.

* Rev. 7/06

Fill slopes between 3:1 and 4:1 are traversable, but non-recoverable slopes, defined as one from which most motorists will be unable to stop or to return to the roadway easily. Vehicles on such slopes typically can be expected to reach the bottom. Since a high percentage of encroaching vehicles will reach the toe of these slopes, the recovery area cannot logically end on the slope. Fixed obstacles should not be constructed along such slopes and a clear runout area (10' min.) at the base is desirable. FIGURE A-2-4 provides an example of a clear zone computation for non-recoverable slopes.

Any non-traversable hazards or fixed objects, including but not limited to those listed in TABLE A-3-1, which are located within the clear zone as determined from TABLE A-2-1 should preferably be removed, relocated, made yielding, or as a last resort, shielded with a barrier.

HORIZONTAL CURVE ADJUSTMENTS

The distances in TABLE A-2-1 may be increased on horizontal curves by the values shown in TABLE A-2-2. See the AASHTO *Roadside Design Guide*, Chapter 3 for further instructions.

These modifications are normally considered where crash* histories indicate such a need, when a specific site investigation shows a definitive crash potential that could be significantly lessened by increasing the clear zone width, and when such increases are cost effective. In these situations, the clear zone distance is increased by the factor in the table below:

RADIUS (ft)	DESIGN SPEED (mph)						
	40	45	50	55	60	65	70
2950	1.1	1.1	1.1	1.2	1.2	1.2	1.2
2300	1.1	1.1	1.2	1.2	1.2	1.2	1.3
1970	1.1	1.2	1.2	1.2	1.3	1.3	1.4
1640	1.1	1.2	1.2	1.3	1.3	1.3	1.4
1475	1.2	1.2	1.3	1.3	1.4	1.4	1.5
1315	1.2	1.2	1.3	1.3	1.4	1.4	-
1150	1.2	1.2	1.3	1.4	1.5	1.5	-
985	1.2	1.3	1.4	1.5	1.5	-	-
820	1.3	1.3	1.4	1.5	-	-	-
660	1.3	1.4	1.5	-	-	-	-
495	1.4	1.5	-	-	-	-	-
330	1.5	-	-	-	-	-	-

TABLE A-2-2
Source: AASHTO *Roadside Design Guide*, Chapter 3

$$CZ_c = (L_c) (K_{cz})$$

Where

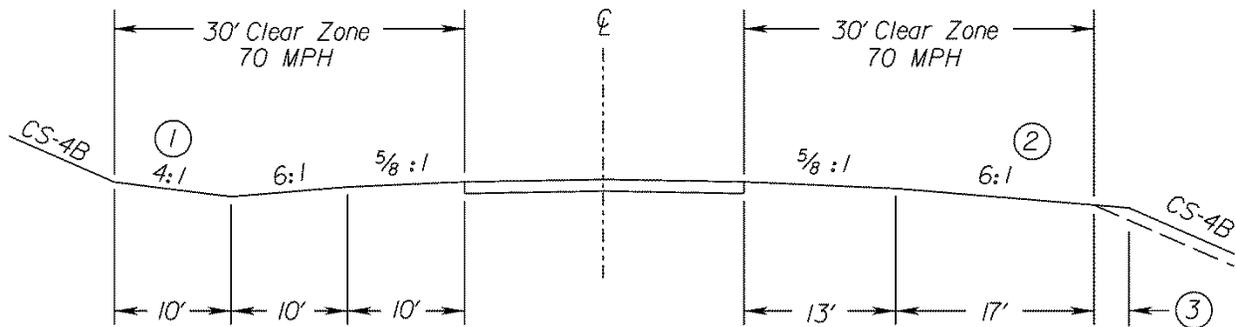
- CZ_c = clear zone on outside of curvature, ft.
- L_c = clear zone distance ft., Table A-2-1
- K_{cz} = curve correction factor

Note: Clear zone correction factor is applied to outside of curves only. Curves flatter than 2950 feet don't typically require an adjusted clear zone.

* Rev. 1/12

SHOWING CLEAR ZONES/ LATERAL OFFSETS ON TYPICAL SECTIONS

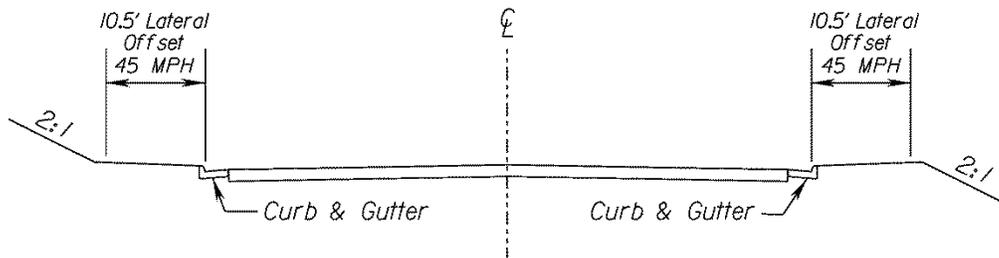
The clear zone width(s) shall be clearly shown on the project typical sections if traversable slopes are being provided so that other divisions will be aware of the desirable clear zones for a project. When varying clear zone widths occur, furnish station to station breakdown. Following are typical methods of showing clear zone/lateral offset data on typical sections.



EXAMPLE OF A TYPICAL RURAL SECTION

(Other Principal Arterial - Std. CS-4B used for example)

Design ADT > 6000



EXAMPLE OF A TYPICAL URBAN SECTION

(Minor Arterial Street used for example)

TYPICAL METHOD OF SHOWING CLEAR ZONE/ LATERAL OFFSET DATA ON TYPICAL SECTIONS

NOTES:

1. If the front slope of ditch is 6:1, the back slope should be 4:1, and if the front slope is 3:1, the back slope should be flat.
2. The preferred slope for recoverable areas with fills is 6:1 or flatter.
3. Width to be increased 3' when Guardrail is required.

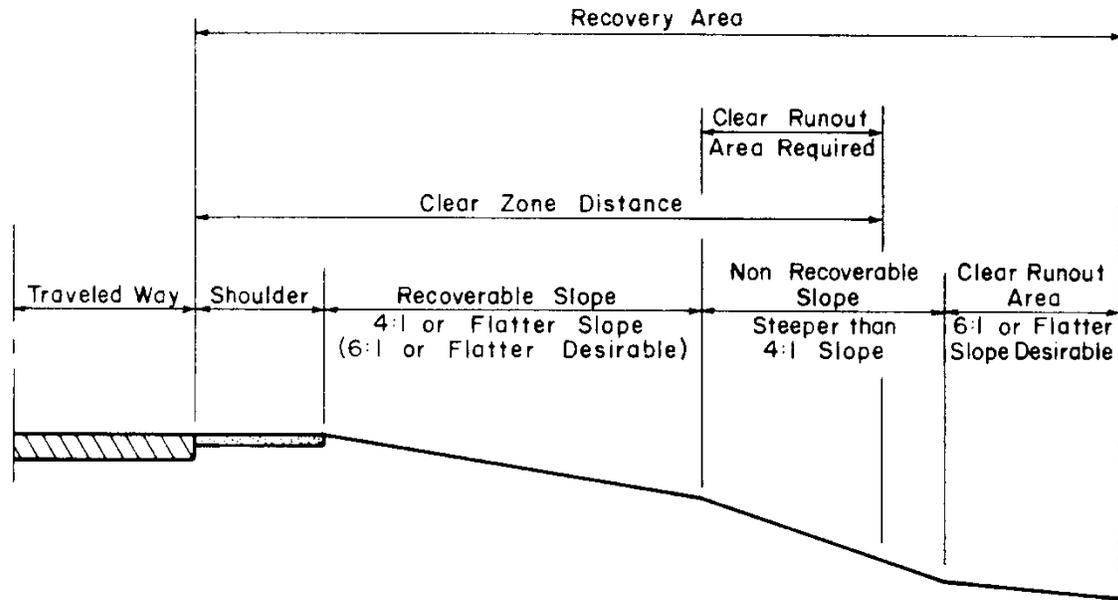


FIGURE A-2-4 EXAMPLE OF A PARALLEL EMBANKMENT SLOPE DESIGN

Source: AASHTO *Roadside Design Guide*, Chapter 3

This figure illustrates a recoverable slope followed by a non-recoverable slope. Since the clear zone distance extends onto a non-recoverable slope, the portion of the clear zone distance on such a slope may be provided beyond the non-recoverable slope if practical. This clear runout area would then be included in the total recovery area. The clear runout area may be reduced in width based on existing conditions or site investigations. Such a variable slope typical section is often used as a compromise between roadside safety and economics. By providing a relatively flat recovery area immediately adjacent to the roadway, most errant motorists can recover before reaching the steeper slope beyond. The slope break may be liberally rounded so an encroaching vehicle does not become airborne. It is suggested that the steeper slope be made as smooth as practical and rounded at the bottom.

NON-RECOVERABLE PARALLEL SLOPES

Foreslopes* from 3:1 up to 4:1 are considered traversable if they are smooth and free of fixed object hazards. However, since many vehicles on slopes this steep will continue on to the bottom, a clear run-out area beyond the toe of the slope is desirable. The extent of this clear run-out area could be determined by first finding the available distance between the edge of the through traveled way and the breakpoint of the recoverable foreslope to the non-recoverable foreslope. This distance is then subtracted from the total recommended clear zone distance based on the slope that is beyond the toe of the non-recoverable foreslope and should be at least 10' if practicable. The result is the desirable clear run-out area. The following example illustrates this procedure:

EXAMPLE

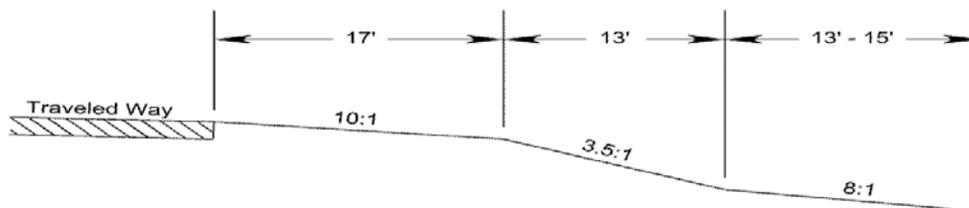
Design ADT: 7000

Design Speed: 60 mph

Recommended clear zone distance for the 8:1 slope: 30-32 feet (from TABLE A-2-1)

Recovery distance before breakpoint of non-recoverable foreslope: 17 feet

Clear run-out area at toe of slope: 30-32 feet minus 17 feet or 13-15 feet



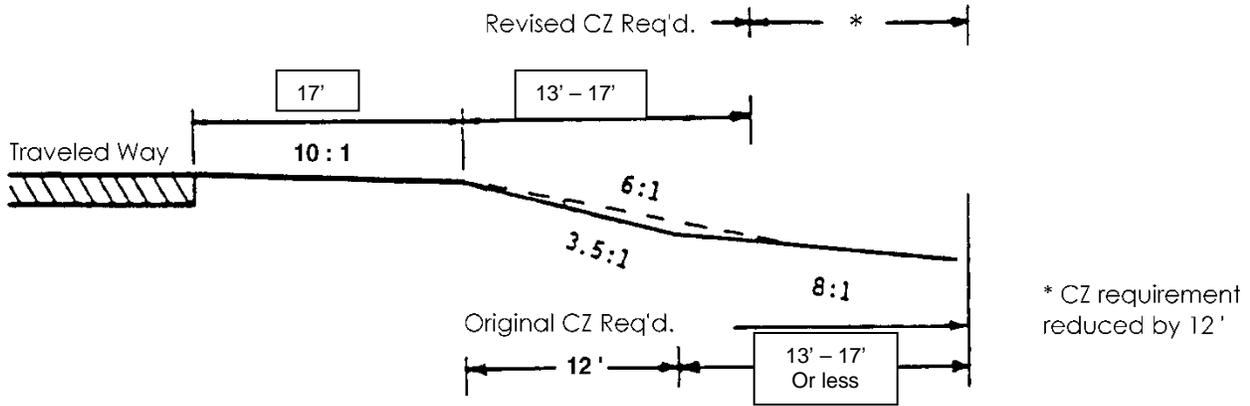
(For Example of Alternate Design to reduce CZ requirement, see below)

Discussion: Using the steepest recoverable foreslope before or after the non-recoverable foreslope, a clear zone distance is selected from Table A-2-1. In this example, the 8:1 slope beyond the base of the fill dictates a 30-32 foot clear zone area. Since 17 feet is available at the top, an additional 13-15 feet could be provided at the bottom. Since this is less than the 10' recovery area that should be provided at the toe of all the non-recoverable slopes, the 10' should be applied. All foreslope breaks may be rounded and no fixed objects would normally be built within the upper or lower portions of the clear zone or on the intervening foreslope.

The designer may find it safe and practical to provide less than the entire 13-15 feet at the toe of the slope. A smaller recovery area could be applicable based on the rounded slope breaks, the flatter slope at the top or past accident histories. A specific site investigation may be appropriate in determining an appropriate recovery area at the toe of the slope.

* Rev. 7/13

**EXAMPLE OF ALTERNATE DESIGN (INCORPORATING MINOR SLOPE ADJUSTMENT)
TO REDUCE TOTAL CLEARANCE REQUIREMENT:**



Source: *Roadside Design Guide*, Chapter 3

When traffic barriers must be provided because hazardous conditions cannot be eliminated, see [Appendix J*](#) - [Barrier Installation Criteria](#).

* Rev. 7/18